Silicon System
Maintenance and Operations(WBS 3.1)

October 2001

Overview

- Silicon system comprised of
  - Pixel detector
  - Silicon strip system
  - Read Out Drivers for these two systems
- U.S. deliverables are about 20% of total
- U.S. Institutions are also about 20% of total pixels+SCT
  - Berkeley/LBNL
  - Iowa State
  - New Mexico
  - Ohio State
  - Oklahoma
  - SUNY Albany
  - UC Santa Cruz
  - Wisconsin

Pixel System

- Pixel System(Project 1.1.1 -> M&O 3.1.1)
  - Most of mechanics(support tube, support frame, disk region)
  - Large fraction of services(cables, piping, etc) within tracker volume
  - About 20% of sensors(silicon detectors)
  - Major design role in IC electronics and system engineering, about 20% of procurement
  - Most of hybrids
  - Module assembly/testing about 25%
- Primary M&O responsibilities
  - Spares - not included. Plan on rapid upgrade.
  - Mechanics engineering-related - pixel system insertion/removal, which will occur relatively often to replace damaged elements(B-layer), beam pipe integrated into pixel support, and for upgrades.
  - Electronics commissioning, operations. Follow through on engineering design responsibilities and systems engineering, including software.
  - General contribution(physicists and technical personnel) to preops, commissioning, operations and maintenance.

Silicon Strip(SCT) System

- Silicon Strip System(Project 1.1.2 -> M&O 3.1.2)
  - Major procurement of IC electronics
  - System management of electronics
  - Systems engineering for electronics
  - Construction of about one-third of barrel modules
- Primary M&O responsibilities
  - Spares procurement(ICs) and production(modules). ICs are unique, early “lifetime buy”.
  - Continuation of system engineering(grounding, shielding, etc) in preoperations&commissioning and initial operations.
  - General contribution(physicists and technical personnel) to preops, commissioning, operations and maintenance.

Read Out Drivers

- Read Out Drivers(Project 1.1.3 -> M&O 3.1.3)
  - VME modules that read out both pixel and SCT modules
  - Unique U.S. responsibility, all modules responsibility of U.S.
  - SCT RODs are to be fabricated soon(starting FY02) for use at macro-assembly sites(where modules are put on mechanical structures)
  - Pixel RODs later, but possibly will be used for same purpose.
- Primary M&O responsibilities
  - Spares procurement/fabrication
  - Preoperations engineering(including software) supporting during use at macro-assembly sites and engineering support of commissioning.
  - General contribution(physicists and technical personnel) to preops, commissioning, operations and maintenance.

General Inner Detector M&O

- In addition to the specific M&O for pixels, SCT and RODs, there is a contribution to the general Inner Detector(ID) M&O.
- This has two major components:(1) general support of the surface assembly(SR) building and (2) contributions of a share of the CERN-provided contract labor for general ID M&O tasks.
- Our Silicon M&O estimates for the general ID M&O(3.1.4) are derived from the estimates made by the ID project leader, using 14% as a guideline(and 7% in TRT budget), since US institutions are also about 20% of total ID institutions.

General Comments

- We have a reasonable concept for personnel and equipment needs through commissioning.
- But U.S. personnel needs for operations and maintenance are less clear at this time. We have made our best estimate but a global ATLAS estimate is needed. Our current model is that this is U.S. personnel but it may be, in part, a financial contribution to CERN-resident personnel instead.
- Contingencies in the current estimate are understood to be low.
- However, we have not taken into account any ongoing support from the institutions except for all physicist costs. There may or may not be ongoing support available for technical personnel.

Pixels(WBS 3.1.1)

- Preoperations and commissioning
  - We have major role in the mechanics that includes interfaces to other systems and installation. Current project funds for installation are in management contingency, low on list.
  - In addition, we have been requested recently to provide the overall pixel project engineer(E. Anderssen) starting June 2003, and a major role for this person will be preoperations and commissioning.
  - We have included mechanical engineering, designer and tech support in this phase.
  - Similarly there is a major role in the overall electronics design, test systems, systems engineering(currently P. Denes) that maps into preoperations and commissioning. Currently no project support of EE after FY03.
  - We have included electrical engineering/systems engineering and some tech support that will surely be needed for preoperations, including initial systems tests, surface testing and CERN and commissioning.
  - Software support is also included. This is a person shared with the RODs during this phase(currently J. Richardson).

Pixels(WBS 3.1.1)

- Operations and maintenance
  - Spares are not currently included in this estimate. We assume there will be a relatively rapid upgrade of the pixel system(WBS 4.1.1).
  - We have projected continued support of unique U.S. deliverables in mechanics that allow removal/re-insertion of the pixel system(ME and some tech support - see next page).
  - We have also provided for a minimal continued support of electronics(EE and some tech support)
  - We have also include technical support for the general operations/maintenance pool(note that there is currently no CERN involvement in the pixel system => technical support from outside CERN likely to be greater than other systems)
  - And we have included software support for DAQ, calibration monitoring, etc

Pixels(WBS 3.1.1) Manpower

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.1.1 | Funding Type: All | 10/18/01 11:19:45 AM

Description: Pixels | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered
Faculty		.3	1.0	2.0	.5	.5	.5	.5	.5	.5	6.3	.0
Sr Research Scientist		.3	1.0	2.0	1.0	1.0	1.0	1.0	1.0	1.0	9.3	.0
Term Scientist	.3	.3	1.0	2.0	.5	.5	.5	.5	.5	.5	6.5	.0
Post Doc		1.0	3.0	7.0	2.0	2.0	2.0	2.0	2.0	2.0	23.0	.0
Grad Student											.0	.0
Mechanical Engineer		1.0	1.0	1.0	1.0	1.0	.4	.4	.4	.4	6.5	.0
Electrical Engineer		.3	1.0	1.0	.5	.5	.2	.2	.2	.2	4.2	.0
Technicial			1.0	1.5	1.8	1.8	1.4	1.4	1.4	1.4	11.5	.0
Computer	.6	.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	9.3	.0
Designer	.3	.3	.5	.5							1.5	.0
Adminsitrator											.0	.0
Contract Labor											.0	.0
TOTAL LABOR	1.1	3.9	10.5	18.0	8.3	8.3	7.0	7.0	7.0	7.0	78.0	.0

Pixels(WBS 3.1.1) Profile

U.S. ATLAS M&&O Estimate
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/18/01 11:28:48 AM

Institutions: All

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)	Total (k$)
3.1.1	Pixels	166	443	907	891	732	732	498	498	498	498	5863
3.1.1.1	Pre-operations and commissioning	166	443	907	891	0	0	0	0	0	0	2406
3.1.1.1.1	SR Building Facilities	73	95	194	124	0	0	0	0	0	0	487
3.1.1.1.2	In-pit/mechanical support	0	189	308	371	0	0	0	0	0	0	868
3.1.1.1.3	Electrical support	0	66	256	246	0	0	0	0	0	0	568
3.1.1.1.4	Software support	93	93	149	149	0	0	0	0	0	0	484
3.1.1.1.5	Physicist support	0	0	0	0	0	0	0	0	0	0	0
3.1.1.2	Operations	0	0	0	0	422	422	302	302	302	302	2050
3.1.1.2.1	Mechanical Support	0	0	0	0	165	165	101	101	101	101	732
3.1.1.2.2	Electrical Support	0	0	0	0	104	104	48	48	48	48	401
3.1.1.2.3	Software support	0	0	0	0	153	153	153	153	153	153	918
3.1.1.2.4	Physicist support	0	0	0	0	0	0	0	0	0	0	0
3.1.1.3	Maintenance	0	0	0	0	310	310	197	197	197	197	1406
3.1.1.3.1	Mechanical support	0	0	0	0	169	169	123	123	123	123	832
3.1.1.3.2	Electrical support	0	0	0	0	141	141	73	73	73	73	575
3.1.1.3.3	Software support	0	0	0	0	0	0	0	0	0	0	0
3.1.1.3.4	Physicist support	0	0	0	0	0	0	0	0	0	0	0
3.1.1.3.5	Spares	0	0	0	0	0	0	0	0	0	0	0

SCT(WBS 3.1.2)

- Preoperations and commissioning
  - Systems engineering(N. Spencer from UCSC) has been vital.
  - Funding for this during construction phase is budgeted through FY03.
  - Continued systems engineering will be needed during preoperations(after modules are delivered and mounted on support structure at Oxford), during surface testing at CERN and during commissioning.
  - Technical support from the SCT institutions will be needed at macro-assembly sites and at CERN, and we have included an estimate of the US portion of this manpower.
  - Equipment expenses for the surface assembly building are also included and are based on CERN estimates.
- Operations
  - Continuation of some systems engineering support, primarily in FY06 and FY07, and then a small level
  - Continued US contribution to technical support pool
  - Minor equipment expenses that we believe will be shared across all institutions/countries

SCT(WBS 3.1.2)

- Maintenance includes spares, minor intervention in FY07(to fix problems seen in first major run) and major intervention in FY11(current ID model)
- Spares
  - Assumption is that major intervention will only be done if 15% of SCT modules need replacement. And that this will be done once during lifetime.
  - Integrated circuit electronics(Atmel DMILL process) likely to become obsolete quickly, frame contract with CERN expires by end of 2003, production planned to be completed by mid-2002 => early “lifetime buy. Funds requested(500K) in FY02.
  - Continue module production line to produce 15% spares in FY04. Current plan has module production ending by October 2003.

SCT(WBS 3.1.2) Manpower

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.1.2 | Funding Type: All | 10/18/01 11:21:44 AM

Description: SCT | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered
Faculty		.3	.3	.3	.4	.1	.1	.1	.2	.1	1.7	.0
Sr Research Scientist	.5	1.5	1.5	2.0	1.3	.2	.2	.2	1.2	.2	8.8	.0
Term Scientist											.0	.0
Post Doc	1.0	2.0	2.5	3.0	2.5	.8	.8	.8	1.8	.8	15.8	.0
Grad Student											.0	.0
Mechanical Engineer											.0	.0
Electrical Engineer		.6	.6	1.1	.5	.1	.1	.1	.1	.1	3.4	.0
Technicial		2.4	1.3	1.3	2.3	1.0	1.0	1.0	2.5	1.0	13.6	.0
Computer											.0	.0
Designer											.0	.0
Adminsitrator											.0	.0
Contract Labor											.0	.0
TOTAL LABOR	1.5	6.7	6.1	7.6	6.9	2.2	2.2	2.2	5.8	2.2	43.3	.0

SCT(WBS 3.1.2) Profile

U.S. ATLAS M&&O Estimate
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/18/01 11:30:24 AM

Institutions: All

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)	Total (k$)
3.1.2	SCT	65	585	306	349	363	151	151	151	348	151	2618
3.1.2.1	Pre-operations and commissioning	65	356	306	349	0	0	0	0	0	0	1076
3.1.2.1.1	Preoperations - LBNL	0	67	67	67	0	0	0	0	0	0	200
3.1.2.1.2	Preoperations - UCSC	0	181	193	270	0	0	0	0	0	0	643
3.1.2.1.3	Preoperations - SR building/CERN	65	108	46	13	0	0	0	0	0	0	232
3.1.2.2	Operations	0	0	0	0	207	141	141	141	141	141	910
3.1.2.2.1	LBNL	0	0	0	0	42	0	0	0	0	0	42
3.1.2.2.2	UCSC	0	0	0	0	133	109	109	109	109	109	675
3.1.2.2.3	SR building/CERN	0	0	0	0	32	32	32	32	32	32	193
3.1.2.3	Maintenance	0	229	0	0	157	10	10	10	207	10	633
3.1.2.3.1	Spares	0	229	0	0	0	0	0	0	0	0	229
3.1.2.3.2	Manpower/materials	0	0	0	0	157	10	10	10	207	10	404

RODs(3.1.3)

- Preoperations and commissioning
  - SCT ROD production will start in 2002. A significant number are planned to be used at the macro-assembly sites(where modules are put on mechanical structures) and at CERN for system tests.
  - We currently plan to fabricate the pixel RODs in 2003(assuming funds are available). Some of these are certain to be used for system tests after fabrication and may be used also at macro-assembly sites.
  - We have included in the M&O estimate most of the technical support(EE and ETech) needed to support commissioning of these RODs at/for the macro-assembly sites and later at CERN and for their maintenance during this period.
  - Only about 1/3 of an FTE of technical support is currently included in the construction project budget in FY03, FY04 and FY05.

RODs(3.1.3)

- Operations and Maintenance
  - We assume spare RODs(for SCT and pixels) are produced in FY03. It would be more cost effective to make a “lifetime buy” of some components in FY02. Although it’s inevitable that there will be an upgrade of the RODs(or equivalent) after some years of operation, we believe fabrication of spares to the current design is justified.
  - The RODs are a unique US responsibility so all operations and maintenance is assumed to be provided by the US.
  - The manpower levels to achieve this are shown on the next page.

ROD(WBS 3.1.3) Manpower

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.1.3 | Funding Type: All | 10/18/01 11:23:10 AM

Description: RODs | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered
Faculty											.0	.0
Sr Research Scientist	.5	.8	1.0	1.0	.9	.1	.1	.1	.1	.1	4.7	.0
Term Scientist											.0	.0
Post Doc	1.0	2.0	2.0	2.0	1.9	.4	.4	.4	.4	.4	10.7	.0
Grad Student											.0	.0
Mechanical Engineer											.0	.0
Electrical Engineer	1.0	1.0	1.0	1.0	1.0	.5	.1	.1	.1	.1	5.9	.0
Technicial					.3	.3	.3	.3	.3	.3	1.5	.0
Computer	.3	.3	.3	.3	.3	.1	.1	.1	.1	.1	1.8	.0
Designer											.0	.0
Adminsitrator											.0	.0
Contract Labor											.0	.0
TOTAL LABOR	2.8	4.0	4.3	4.3	4.3	1.3	.9	.9	.9	.9	24.6	.0

ROD(3.1.3) Profile

U.S. ATLAS M&&O Estimate
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/18/01 11:32:01 AM

Institutions: All

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)	Total (k$)
3.1.3	RODs	498	218	221	231	258	150	78	78	78	78	1887
3.1.3.1	Pre-operations and commissioning.	218	218	221	231	0	0	0	0	0	0	888
3.1.3.1.1	Wisconsin	179	179	182	192	0	0	0	0	0	0	731
3.1.3.1.2	LBNL	39	39	39	39	0	0	0	0	0	0	157
3.1.3.1.3	Iowa State	0	0	0	0	0	0	0	0	0	0	0
3.1.3.2	Operations	0	0	0	0	222	113	41	41	41	41	498
3.1.3.2.1	Wisconsin	0	0	0	0	182	95	23	23	23	23	368
3.1.3.2.2	LBNL	0	0	0	0	39	18	18	18	18	18	130
3.1.3.2.3	Iowa State	0	0	0	0	0	0	0	0	0	0	0
3.1.3.3	Maintenance	280	0	0	0	37	37	37	37	37	37	501
3.1.3.3.1	Spares	280	0	0	0	0	0	0	0	0	0	280
3.1.3.3.2	Personnel/materials	0	0	0	0	37	37	37	37	37	37	221

General ID

- The U.S. pixel + SCT institutions are about 14% of total ID institutions
- General support of the surface assembly building and equipment of general use across the ID is to be provided by the institutions.
- Contract labor supplied by CERN(eg. for cabling, plumbing, on-site machining, etc) related to the ID must also be provided by the institutions. We treat this as a procurement, not labor in database.
- Consumables(gases, coolant fluids, etc) also.
- The ID Project Leader has estimated these, and we have used his estimates as a guideline basically scaling by 14% - see next page.
- Note FY03 estimate reduced to meet funding targets.

General ID/Silicon(WBS 3.1.4)

U.S. ATLAS M&&O Estimate
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/18/01 11:33:41 AM

Institutions: All

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)	Total (k$)
3.1.4	Common Silicon/ID	60	135	162	158	144	129	129	129	188	99	1332
3.1.4.1	Pre-operations	60	135	162	158	0	0	0	0	0	0	515
3.1.4.1.1	SR Building	0	64	64	45	0	0	0	0	0	0	173
3.1.4.1.2	CERN labor	22	32	59	73	0	0	0	0	0	0	187
3.1.4.1.3	ID general	39	39	39	39	0	0	0	0	0	0	156
3.1.4.2	Operations	0	0	0	0	16	16	16	16	16	16	97
3.1.4.2.1	ID General	0	0	0	0	16	16	16	16	16	16	97
3.1.4.3	Maintenance	0	0	0	0	127	112	112	112	172	83	719
3.1.4.3.1	SR Building	0	0	0	0	68	68	68	68	39	39	350
3.1.4.3.2	CERN labor	0	0	0	0	59	44	44	44	133	44	369

WBS 3.1 Total Manpower

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 3.1 | Funding Type: All | 10/18/01 11:26:49 AM

Description: Silicon | Institutions: All | Funding Source : All

	FY03	FY04	FY05	FY06	FY07	FY08	FY09	FY10	FY11	FY12	Calculated Total	Entered
Faculty		.5	1.3	2.3	.9	.6	.6	.6	.7	.6	8.0	.0
Sr Research Scientist	1.0	2.5	3.5	5.0	3.2	1.3	1.3	1.3	2.3	1.3	22.7	.0
Term Scientist	.3	.3	1.0	2.0	.5	.5	.5	.5	.5	.5	6.5	.0
Post Doc	2.0	5.0	7.5	12.0	6.4	3.1	3.1	3.1	4.1	3.1	49.5	.0
Grad Student											.0	.0
Mechanical Engineer		1.0	1.0	1.0	1.0	1.0	.4	.4	.4	.4	6.5	.0
Electrical Engineer	1.0	1.9	2.6	3.1	2.0	1.1	.4	.4	.4	.4	13.5	.0
Technicial		2.4	2.3	2.8	4.3	3.0	2.6	2.6	4.1	2.6	26.6	.0
Computer	.9	.9	1.3	1.3	1.3	1.1	1.1	1.1	1.1	1.1	11.0	.0
Designer	.3	.3	.5	.5							1.5	.0
Adminsitrator											.0	.0
Contract Labor											.0	.0
TOTAL LABOR	5.4	14.6	20.9	29.9	19.5	11.7	10.1	10.1	13.7	10.1	145.8	.0

WBS 3.1 Profile

U.S. ATLAS M&&O Estimate
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/18/01 11:35:22 AM

Institutions: All

WBS Number	Description	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	FY 06 (k$)	FY 07 (k$)	FY 08 (k$)	FY 09 (k$)	FY 10 (k$)	FY 11 (k$)	FY 12 (k$)	Total (k$)
3.1	Silicon	789	1381	1596	1628	1497	1161	855	855	1111	826	11700
3.1.1	Pixels	166	443	907	891	732	732	498	498	498	498	5863
3.1.1.1	Pre-operations and commissioning	166	443	907	891	0	0	0	0	0	0	2406
3.1.1.2	Operations	0	0	0	0	422	422	302	302	302	302	2050
3.1.1.3	Maintenance	0	0	0	0	310	310	197	197	197	197	1406
3.1.2	SCT	65	585	306	349	363	151	151	151	348	151	2618
3.1.2.1	Pre-operations and commissioning	65	356	306	349	0	0	0	0	0	0	1076
3.1.2.2	Operations	0	0	0	0	207	141	141	141	141	141	910
3.1.2.3	Maintenance	0	229	0	0	157	10	10	10	207	10	633
3.1.3	RODs	498	218	221	231	258	150	78	78	78	78	1887
3.1.3.1	Pre-operations and commissioning.	218	218	221	231	0	0	0	0	0	0	888
3.1.3.2	Operations	0	0	0	0	222	113	41	41	41	41	498
3.1.3.3	Maintenance	280	0	0	0	37	37	37	37	37	37	501
3.1.4	Common Silicon/ID	60	135	162	158	144	129	129	129	188	99	1332
3.1.4.1	Pre-operations	60	135	162	158	0	0	0	0	0	0	515
3.1.4.2	Operations	0	0	0	0	16	16	16	16	16	16	97
3.1.4.3	Maintenance	0	0	0	0	127	112	112	112	172	83	719

Manpower Check

- We have estimates of the manpower currently working on the BaBar SVT and CDF silicon tracker.
- There are about 20 FTEs(physicists) currently working on the BaBar SVT, of which about 8 are working on replacement. Technical manpower is not well accounted.
- There are about 30 heads(physicists) working on CDF silicon, FTE level not well known, somewhere between 0.5 and 1. Technical manpower not well accounted.
- Scaling to ATLAS silicon is greater than factor of 2. Pixels and SCT are and will be distinct systems(factor of 2). Both systems much more complex than either BaBar or CDF. And at CERN. Another factor of 2?
- Rough check is to take 20 FTEs x 4 x 0.14 = 11 FTEs to be compared with our 10 FTEs in steady operation, including technical manpower.

M&O Conclusions

- Estimates during preoperations and commissioning phase are realistic if on the lean side. Contingency as given in the estimate is likely low, but hopefully ongoing institutional support will fill in some of the cracks.
- We have included early spare procurement/fabrication for SCT and RODs, which we believe is prudent and necessary. Somewhat risky assumption is that pixel upgrades will occur rapidly enough in case of early problems. Need upgrade funding early for this, not addressed in M&O estimate.
- Operations and maintenance personnel estimates are more uncertain, have done best estimate we can at this time. More global picture needed.
- General CERN-supplied expenses based on ID estimates.